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Angular dependence of luminescence from GaAs/AlGaAs DQW

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This paper reports the exciton photoluminescence (PL) study of GaAs/AlGaAs double quantum well (DQW). The particular interest is paid to the luminescence behaviour of the indirect exciton (IX) consisting of the electron (e) and a hole (h) localized in the different quantum wells (QW) of the same DQW. This IX architecture leads to the existence of distinct dipole moment in the system of IX gas and moreover to the essentially longer radiative lifetime compare to the direct excitons which are composed from e and h located in the same QW. All this makes it possible to expect some new properties in the IX system. For example, the long ($\approx 1\ \mu$s) radiative lifetime allows one to create the IX gas of high density ($10^{10}\ \mathrm{cm}^{-2}$) even at moderate pumping intensities (≈ 1 mW) and as a result to expect the appearance of a new collective phase in the dense IX gas which was predicted theoretically [ ]. Experimental results on the IX PL properties which can be interpreted in the frame of the manifestation of new phase in the dense IX system were published recently [ ].

In this contribution we present the external electric field (V_{dc}) induced changes in the low-temperature ($T = 1.8$ K) PL spectra of IX recorded on the DQW samples (detailed sample description and experimental setup are given elsewhere [ ]) as a function of an angle α in between plane of the sample and PL detection direction (optical axis). It was observed that PL spectra taken at $\alpha = 90^\circ$ show almost no changes in the full width at half maximum (FWHM) as well as in the shape of the IX PL line which progressively shifts to low energies with increasing of V_{dc} while those taken at $\alpha = 60^\circ$ behave in quite a different way. Namely, as V_{dc} increases, IX line shape shows more and more pronounced double peak structure which leaves only single PL line at moderate V_{dc}'s. With further increase of V_{dc} this single line consistently narrows and broadens as was reported in our earlier observation [ ]. We consider this strong angular dependence originates from clearly pronounced dipole moment in the system of spatially separated excitons and discuss the experimental results in terms of radiation diagrams of variously oriented IX dipoles.

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References

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